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NOTES ON REPLETES, MYRMECOPHILES, AND PREDATORS OF HONEY ANT NESTS (*MYRMECOCYSTUS MEXICANUS*) (HYMENOPTERA: FORMICIDAE) IN ARIZONA

JOHN R. CONWAY

Department of Biology, University of Scranton, Scranton, Pennsylvania 18510

Abstract.—Three nests of the honey ant, *Myrmecocystus mexicanus,* were excavated near Portal, Arizona and 548 of the 692 repletes in one colony were analyzed by color: 249 dark amber, 230 amber, 68 milky and 1 clear. Crop fluid of milky repletes contained the most protein. Replete abdomens were 6–12 mm long and weights ranged from 0.09–0.98 g. Dark amber and amber repletes had larger average abdominal lengths and weights than milky and clear ones. Replete chambers ranged in depth from 0.3–1.6 m. The number of repletes per chamber varied from 8–240. A wingless queen was in each nest but one colony also contained 112 winged males and 110 winged females. Probable predation by badgers on two nests was noted. An ant-loving cricket (*Myrmecophila* sp.) and collembolans in one nest are new myrmecophiles for this species.

Honey ants in the genus *Myrmecocystus* inhabit arid and semiarid areas of western North America and are unusual in producing swollen workers called repletes to store the seasonal flow of nectar (McCook, 1882; Wheeler, 1908; Snelling, 1976).

This paper discusses excavations of three *M. mexicanus* nests along the San Simon road about 4 kilometers northeast of Portal, Arizona at an elevation of about 1,433 m during the summers of 1982, 1985 and 1986.

MATERIALS AND METHODS

A *M. mexicanus* nest was carefully excavated 26 July–3 August 1986 by first digging two right-angle trenches about 1.8 m deep and 1 m from the entrance with a backhoe. The color, turgidity, and abdominal length of 548 repletes were noted and the ants weighed on a Mettler PB 300 balance. The Lowry procedure (Sigma Protein Assay Kit No. P5656) was used to quantitatively analyze soluble proteins in 148 repletes. Crop contents were extracted using a syringe with a 26 gauge needle and analyzed with an IBM-9420 UV-Visible spectrophotometer to determine total protein (μg/ml) at 540 nm absorbance. Two other nests were excavated manually with picks, shovels, and trowels in June 1982 and July 1985.

RESULTS AND CONCLUSIONS

Replete chambers. The average depth at which repletes were first encountered was 1.7 times greater in three Arizona ($\bar{x}$ = 49.7 cm) nests than in three Colorado ($\bar{x}$ = 29.3 cm) nests (Table 1). Others (McCook, 1882; Wheeler, 1910; Slocumb, 1966) also report the uppermost repletes in Colorado at shallow depths (8–35 cm). Perhaps the deeper Arizona chambers protect repletes from dehydration at higher tempera-

Table 1. Comparison of Arizona and Colorado nests of *Myrmecocystus mexicanus*.

Nest location, date	Depth of uppermost replete chambers (m)	Number of replete chambers	Number of repletes per chamber (min–max)	Total number of repletes	Maximum nest depth (m)
Portal, AZ July–Aug, 1986	0.58	11	8–240	692	1.6
Portal, AZ July, 1985	0.61	—	—	—	1.2
Portal, AZ June, 1982	0.30	—	—	—	1.4
Colorado Sprgs, CO June, 1973	0.17	19	1–149	806	1.8
Colorado Sprgs, CO Jan, 1973	0.20	21	1–348	1,030	1.4
Colorado Sprgs, CO Oct, 1972	0.51	7	2–28	—	1.1
Mean	0.40	14.5	—	843	1.4

tures. Rissing's (1984) excavation of an Arizona nest went even deeper, 1.3 m, without finding repletes.

Ninety-one percent of 692 repletes were in the bottom half of the Arizona nest (below 81.5 cm). In two Colorado nests, fewer repletes were in the lower half: 469 of 1030 (46%) and 348 of 806 (43%) (Conway, 1975). Thus, distribution of repletes in nests varies and may change in the same nest at different times of the year.

The 1986 Arizona nest had 11 replete chambers and the number in three Colorado colonies varied from 7–21. Snelling and George (1979) report more than 20 chambers in some nests. The number of repletes per chamber varied from 8–240 in the Arizona nest vs. 1–348 in Colorado nests (Table 1) (Conway, 1983). Variations in the number of chambers and repletes per nest probably indicate differences in colony age and/or abundance of food.

Maximum depths of Arizona nests, 1.2–1.6 m ($\bar{x}$ = 1.4 m), are similar to Colorado nests, 1.1–1.8 m ($\bar{x}$ = 1.4 m) (Table 1) (Conway, 1983). Other reports (McCook, 1882; Cazier and Mortenson, 1965; Slocumb, 1966) indicate greater variation, 0.8–2.3 m, and Snelling and George (1979) found a nest in California 4 m deep.

Myrmecophiles. Two new myrmecophiles were found in the 1986 Arizona excavation. An ant-loving cricket, *Myrmecophila* sp. (Family Gryllidae, Subfamily Myrmecophilinae) was in the deepest replete chamber (1.63 m) and springtails (Order Collembola) were in a chamber at 1.42 m. *Cremastocheilus* beetles are well-known myrmecophiles of *Myrmecocystus* in the Portal area that eat ant larvae. Cazier and Mortenson (1965) found 4–18 *C. stathamae* beetles in *M. mexicanus* nests. In 1986 I collected 4 *Cremastocheilus* beetles in surface passages and the 1982 excavation yielded 12 beetles between 17.8–55.9 cm.

Predators. Predation on honey ants seems low. In 1982 I found two *M. mexicanus* colonies partially unearthed, possibly by a badger (*Taxidea taxus*) (Chew, 1979). The first nest had a large burrow 27.9 cm from the entrance with an opening 27.9 cm by

Table 2. Analysis of repletes by color from 1986 excavation of *Myrmecocystus mexicanus* nest near Portal, Arizona.

Color of abdomen	Number of repletes N = 548	Protein content (μg/ml) N = 148	Mean abdominal length (mm) N = 548	Mean weight (g) N = 547
Dark amber	249	944.2 N = 60	10.76	0.67
Amber	230	927.3 N = 78	10.01	0.55
Milky	68	9,686.7 N = 9	9.36	0.30
Clear	1	1,700 N = 1	9.00	0.09
Range		230–26,900	6–12	0.09–0.98
Mean		1,472	—	0.57

38.1 cm. At the second colony the opening was 38.1 cm from the entrance and measured 20.3 cm by 25.4 cm. The only other predation I observed were spiders (*Euryopsis* sp.) carrying dead workers on scrub oaks in Colorado (Conway, 1985).

Reproductives. One wingless queen is in each *M. mexicanus* nest. The queen from the 1986 nest lived longer (473 days) than seven captured after their mating flights in Colorado (181 to 384 days, $\bar{x}$ = 297.6) (Conway, 1981). The 1982 excavation uncovered 112 winged males and 110 winged queens as well as the wingless queen. The number of winged reproductives I counted in Colorado nests ranged from 56–209 queens and 100–110 males (Conway, 1980a, 1983). These numbers suggest the reproductive potential of colonies differs considerably.

Analysis of Repletes

Coloration. Numbers, colors, and percentages of 548 repletes from the 1986 excavation were: 249 dark amber (45.4%), 230 amber (42%), 68 milky (12.4%) and 1 clear (0.2%). Dark amber and amber repletes were also more abundant in Colorado nests. Replete coloration may relate to different food sources. Amber and dark amber ants contain glucose and fructose and probably store nectar from flowering plants, galls and homopterans. Clear repletes contain large quantities of water and small amounts of sucrose (McCook, 1882; Snelling, 1976; Conway, 1977, 1980a). Milky repletes contain oil droplets and may store fluids from insect prey (Snelling, 1976). Burgett and Young (1974) found biphasic repletes in an Arizona *M. mexicanus* colony, containing carbohydrate and lipid layers.

Clear repletes were more numerous in two Colorado nests (22 and 35) (Conway, 1975) than the Arizona nest (1), but milky repletes (68) were only in the Arizona nest (Table 2). These findings are difficult to explain since we might expect more clear repletes in Arizona nests to store scarce water and milky repletes in Colorado nests to store dead insects that were brought back (Conway, 1980b).

Abdominal turgidity and gas. Abdomens of 548 Arizona repletes were categorized as turgid, turgid with gas bubbles, flaccid, or flaccid with gas bubbles. The majority

of dark amber (98%) and amber (76%) repletes were turgid. The single clear replete had a bubble filling most of the abdomen. Flaccidity and bubbles were also more common in milky repletes perhaps indicating digestion or fermentation of crop contents.

Protein analysis. Mean total protein for 148 repletes was 1,472.0 μg/ml, but varied according to abdominal color. Protein content was about equal in amber (927.3) and dark amber repletes (944.2), but 1.8 times greater in the clear replete (1,700) and over 10 times more in milky repletes (9,686.7) (Table 2). The higher concentration in clear repletes is difficult to explain if their function is to store water, but was not totally unexpected since a previous analysis revealed amino acids (Conway, 1977). Higher protein in milky repletes is consistent with insect storage.

Abdominal length and weight. Abdominal lengths of 548 Arizona repletes ranged from 6–12 mm. Average lengths varied by color: dark amber ($\bar{x}$ = 10.76 mm); amber ($\bar{x}$ = 10.01 mm); milky ($\bar{x}$ = 9.36 mm); and clear (9 mm). Weights of 547 repletes ranged from 0.09–0.98 g ($\bar{x}$ = 0.57 g). If a replete is defined as having an abdominal length 10 mm or more, then 420 were repletes (mean weight = 0.64 g). The remaining 127 semi-repletes had a mean weight = 0.33 g. Mean weights varied by color: dark amber ($\bar{x}$ = 0.67 g); amber ($\bar{x}$ = 0.55 g); and milky ($\bar{x}$ = 0.30 g) (Table 2).

The progression from most numerous, heaviest and longest to least numerous, lightest and shortest was: dark amber; amber; milky; and clear. Low weights of milky and clear ants seem related to more abdominal gas, flaccidity and smaller size. Clear repletes also contain fewer dissolved solids (Conway, 1977). The weight of full turgid dark amber repletes increased an average of 0.08 g for each 0.5 mm increase in length.

The average replete, 0.64 g, is 299 times heavier than a worker (mean dry weight = 2.14 mg) (Chew, 1987). Total "honey" stored in the 692 swollen ants ($\bar{x}$ = 0.57 g) of the 1986 Arizona nest is about 394 g.

Development from workers. Semi-repletes developed from workers in Colorado laboratory colonies given only water and repletes formed in colonies given sugar water. Semi-repletes appeared in 8 nests 15–89 days ($\bar{x}$ = 50.4) after introduction of sugar water or water and repletes developed in 4 nests 14–222 days ($\bar{x}$ = 77.3) after the addition of sugar water. Thus, it takes about 4 weeks longer, on average, for a semi-replete to become fully distended (Conway, 1975, 1977). These times are longer than other reports. Wheeler (1910) believed repletes develop only from callows and reported 28–42 days to form semi-repletes and repletes. I saw semi-repletes and repletes form from both callows and mature workers (Conway, 1975) and Rissing (1984) also formed repletes in 24 days from non-callow workers fed honey water and crickets.

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